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Parasomnias and isolated sleep symptoms in Parkinson's disease: A questionnaire study on 661 patients

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ABSTRACT

Background: Sleep disorders are among the most common non-motor symptoms in Parkinson's disease.
Method: The prevalence of parasomnias and their association with other symptoms were studied in a questionnaire study among 1447 randomly selected Parkinson patients, aged 43 to 89 years. The response rate was 59.0% and of these 77% had answered to all questions that were used in the analyses ($N = 661$).
Results: The prevalence of REM sleep behavior disorder (RBD) evaluated by the RBDSQ ≥ 6 was 39.0%. The occurrences of other parasomnias (≥1/week) in patients with PD were: nightmares 17.2%, night terrors 3.9%, sleepwalking 1.8%, enuresis 21.0%, and hallucinations 15.3%. Occurrences (≥1/week) of the isolated sleep symptoms were: nocturnal sweating 28.8%, bruxism 4.7%, and sleep talking 21.7%. Association of RBD with sleepwalking (parasomnia overlap disorder) was found in 1.7% of all PD patients. Adjusted logistic regression analysis showed that weekly nightmares (OR 12.5; 95% CI 5.3 to 29.7), hallucinations (OR 5.1; 2.1 to 12.4), sleep talking (OR 11.6; 5.9 to 22.8), male gender (OR 1.9; 1.1 to 3.1), and restless legs syndrome (OR 4.7; 1.7 to 13.2) associated with the presence of RBD.
Conclusion: Parkinson patients with RBD have often also other parasomnias and/or isolated sleep symptoms.

1. Introduction

Although Parkinson's disease is defined by its motor symptoms, the non-motor symptoms of the disease such as sleep disorders have a significant impact on patients' well-being and quality of life as well. The majority of patients suffer from sleep disturbances affecting their ability to fall asleep, ability to stay asleep, dreams, motor activity during sleep, post-sleep behavior, or day-time somnolence. Among different sleep disorders parasomnias have often been overlooked.

According to the latest International Classification of Sleep Disorders (ICDS-3) three sleep disorders are classified as REM sleep parasomnias, namely REM sleep behavior disorder (RBD), recurrent isolated sleep paralysis, and nightmare disorder [1].

The NREM parasomnias are disorders of arousal from NREM sleep, with impaired sleep–wake transitions that can result in activation of physiologic systems. Sleepwalking (SW), confusional arousals, sleep terrors and sleep related eating disorder may occur when the transition from slow-wave sleep to wakefulness is disrupted [1].

The third category of parasomnias, classified as "other parasomnias", includes sleep-related dissociative disorder, sleep enuresis, exploding head syndrome, and sleep related hallucinations [1]. Additionally to these, parasomnias may be due to drug, other substance, or medical condition.

Sleep talking (ST), sleep bruxism (SB), and nocturnal sweating are classified in the new classification as isolated symptoms [1]. ST is a common phenomenon that may occur during REM or NREM sleep. SB is a parafunctional activity during sleep that is characterized by clenching (tonic activity) and/or the repetition of phases of muscle activity (phasic activity) that produce grinding of the teeth. Most SB episodes (60–80%) occur in light non-REM sleep [2].

Autonomic physiology in PD is of particular interest, since it underlies several non-motor symptoms, including orthostatic dizziness, constipation, urinary problems, erectile dysfunction, drooling, sweating and swallowing problems [3]. Of these hyperhidrosis and urinary problems can disturb the sleep of PD patients. It is important to make the distinction between nocturnal enuresis (a parasomnia, i.e. urinary incontinence while asleep), and nocturia, i.e. frequent urgency to urinate during night, which can also lead to bedwetting especially when combined with rigidity and slow movements.

According to the ICSD-3 the diagnosis of a typical parasomnia can be based on history and clinical examination. A polysomnography is not necessary, but in case of doubt it is recommended [4]. The diagnosis of

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RBD can be based on history but the definitive diagnosis of RBD requires polysomnographic (PSG) documentation as one of the essential diagnostic criterion is REM sleep without muscle atonia (RWA). Therefore the diagnosis is usually based on questionnaires and interviews. Several RBD screening instruments have been developed to facilitate the identification of clinical RBD, e.g. RBDSQ [5]. In addition to the Marburg questionnaire at least three other questionnaires exist: RBDSQ-J [6], RBDQ-HK [7] and MSQ [8]. Nomura et al. used RBDSQ (Marburg) in patients with PD [9].

For the majority of PD patients, sleep is disrupted. On the other hand, factors that fragment sleep, e.g. PD, can facilitate or precipitate parasomnias in predisposed individuals [4]. Previous studies of the occurrence of parasomnias in patients with PD are scarce [10,11]. Our aim is to evaluate in a Parkinsonian population the occurrence of different parasomnias and isolated symptoms, as defined in the ICSD-3.

2. Subjects and methods

Total 5373 subjects with a diagnosis of PD were included in the registry of the Finnish Parkinson Association. Altogether 1500 patients with Parkinson's disease were randomly selected from the registry. We computed random numbers, based on the registration number in the registry. This allowed us to have a representative sample of all subjects in the registry. After an initial selection we found that forty-nine subjects were either deceased or hospitalized (unable to answer), two were relatives of Parkinson's patients, one had dystonia without Parkinson's disease and one was a healthy person. These persons were excluded and the remaining number of eligible patients was 1447. A new questionnaire was sent to those participants who did not respond within three months. The patients were defined as having Parkinson's disease, a) if their diagnosis had been confirmed by a neurologist and b) they used a typical antiparkinsonian medication. Due to the nature of a questionnaire study, most likely subjects with a cognitive dysfunction, e.g. patients with Lewy body disease, were among non-responders.

The structured questionnaire with 207 items included questions derived from the Basic Nordic Sleep Questionnaire (BSNQ) [12,13]. The basic five alternatives for the responses were: 1) "never or less than once per month", 2) "less than once per week", 3) "on 1–2 days per week", 4) "on 3–5 days per week" and 5) "daily or almost daily". The diagnosis of the restless legs syndrome (RLS) is based in Finland on the four main criteria of the International RLS Study group and on the NIH criteria. In our study we asked if the diagnosis had been diagnosed by a physician. The presence of obstructive sleep apnea (OSA) was asked separately according to the validated BNSQ with a question: "Have you had breathing pauses (sleep apnea) at sleep (have other people noticed that you have pauses in respiration when you sleep)? ". We asked separately for fatigue and daytime sleepiness. In this study, daytime fatigue was asked as "Do you feel fatigued during daytime?" Excessive sleepiness was evaluated by the Epworth Sleepiness Scale (ESS) [14]. In our experience, mentally fatigued people (often depressive) usually do not have high scores in the ESS as opposed to sleepy patients with, say, sleep apnea or narcolepsy. Intense dreaming was defined as recalling dreams nightly. RBDSQ as a screening tool for secondary RBD among PD patients has been validated [9].

The DSM-IV criteria were used to define chronic insomnia (primary insomnia). Persons were defined as insomniac if:

A. they answered positively to the question: "Have you suffered from insomnia at least for one month", and B. positively to at least one of the following three symptoms:

a. "Have you slept 6 h or less per night at least 16 nights per month?"
b. "Have you waked up too early without being able to sleep again at least three mornings per week"
c. " Have you suffered unrefreshing (non restorative) sleep at least for one month? " and C. positively to "Is your sleep disturbance affecting negatively your social life, working life or leisure time ?"

About different other parasomnias and isolated symptoms the questionnaire included 11 items including: nightmares, night terrors, SW, enuresis, hallucinations, ST, SB and nocturnal sweating. Hallucinations were separated in four different questions: 1) hallucinations during evening when awake, 2) hallucinations at the moment of falling asleep, 3) hallucinations at the moment of awakening and 4) hallucinations during night. The time period was the last year. In these questions a sixth response alternative was given by separating 0) "never" from 1) "less than once per month". In this study, other parasomnias and isolated symptoms were asked separately as "How often during last year you have had this disturbance?"

The health-related quality of life was evaluated using the Euroqol (EQ-5D) questionnaire and visual-analog scale (VAS) [15]. The quality of life is considered poor if the value is less than 60 [16]. Depression was evaluated using an easy screening method for general practice, i.e. Rimon's Brief Depression Scale (score 0–21). The limit for depression is 10 [17].

All statistical analyses were conducted using Stata 12.0 (Copyright 1985–2011 StataCorp LP). Quantitative values were expressed as medians, means, standard deviations and ranges. The normality of the distributions was tested with the Shapiro–Wilk normality test. For continuous variables parametric (Student's *t*-test) or nonparametric methods (Mann–Whitney *U*-test) were used depending of the distribution. Categorized values were expressed in numbers and percentages and analyzed by the Pearson's chi-square test and Fisher's exact test. Values of $P < 0.05$ were considered statistically significant. Logistic regression analysis was used to compute odds ratios (OR) and their 95% confidence intervals (CI). Examples of predicted probabilities were computed with the prvalue command of the STATA. With the prvalue the predicted probability of having RBD can be computed, when the other characteristics of the defined model are known. The ethical permission was obtained from the local ethical committee and the study was conducted according to the declaration of Helsinki.

3. Results

The response rate was 59% ($N = 854$), and of these 77% returned fully answered questionnaire ($N = 661$). In this cohort, the mean age of the responders was 68.8 years (SD 8.5; median 69 years; range [43 to 89]), and 53.0% of them were male. The median duration of Parkinson's disease was 5 years (mean 6.1 y, SD 4.9). Quality of life measured using EQ VAS was poor (<60) in 43.6 % of patients. Answers indicating depression (Depression scale ≥ 10) were found in 20.9% of the subjects, and fatigue in 43.3%.

Occurrence of previously diagnosed restless legs syndrome (RLS) was 5.6%, obstructive sleep apnea (OSA) was 13.6%, chronic insomnia was 32.5%, excessive daytime sleepiness (ESS > 10) was 30.6%, intense dreaming was 14.5%, and RBD according to the questionnaire study was 39.0% (258/661 PD patients).

REM sleep parasomnia (weekly nightmares), NREM sleep parasomnias (at least weekly occurring night terrors and sleep walking), other parasomnias (at least weekly enuresis and hallucinations), and isolated sleep symptoms (at least weekly nocturnal sweating, bruxism, and sleep talking) were all, i.e. as each and every one and as a group, significantly related to RBD. RBD without coexisting other parasomnias or isolated sleep symptoms was rare (35/661 PD patients; 5.3%). In other words 86.4% (223/258) of the PD patients with RBD had at least one other parasomnia or some isolated sleep symptoms as mentioned above. Their occurrences as such and as a whole group, and with and without RBD, are shown in Table 1. Association of RBD with sleepwalking (parasomnia overlap disorder) was found in 1.7% (95% CI 0.7% to 2.6%) of all participants. Sleepwalking at least once weekly was reported by only one (0.2%) PD patient without RBD while it was reported by 11 (4.3%) of the 258 patients with RBD ($P < 0.001$).

Although 45/114 (39.5%) of the PD patients with weekly nightmares had also hallucinations, 69/114 (60.5%) were not hallucinating. On the

Table 1
Occurrence (%) of parasomnias and isolated sleep symptoms in patients with Parkinson's disease.

	All patients With PD % (95% CI)	PD without RBD (95% CI)	PD with RBD (95% CI)	*P*-value (RBD− vs RBD+)
N (%)	661	403 (61.0)	258 (39.0)	
REM parasomnias (≥once per week)	41.3% (37.5–45.1)	–	–	
RBD	39.0 % (35.3–42.8)	0.0 %	100.0 %	
Nightmares	17.2 % (14.3–20.2)	3.8 % (1.9–5.7)	38.3 % (32.3–44.4)	0.000
NREM parasomnias (≥once per week)	4.7% (3.0–6.4)	0.8% (0.1–1.7)	11.1% (7.0–15.2)	0.000
Night terrors	3.9 % (2.4–5.5)	1.0 % (0.2–2.1)	8.7 % (5.0–12.4)	0.000
Sleep walking	1.8 % (0.8–2.8)	0.2 % (0.0–0.7)	4.3 % (1.8–6.7)	0.000
Other parasomnias (≥once per week)	29.7% (26.1–33.2)	18.5% (14.6–22.3)	47.9% (41.6–54.3)	0.000
Enuresis	21.0 % (17.8–24.1)	13.5 % (10.1–16.9)	32.9 % (27.0–38.9)	0.000
Hallucinations	15.3 % (12.5–18.1)	6.1 % (3.7–8.5)	30.0 % (24.2–35.7)	0.000
Isolated symptoms (≥once per week)	43.9% (39.9–47.9)	30.5% (25.8–35.3)	65.8% (59.5–72.0)	0.000
Nocturnal sweating	28.8 % (25.2–32.3)	25.8 % (21.5–30.2)	33.3 % (27.4–39.2)	0.042
Bruxism	4.7% (3.1–6.4)	2.6% (1.0–4.1)	8.2% (4.8–11.7)	0.001
Sleep talking	21.7% (18.5–24.9)	5.6% (3.3–7.9)	47.7% (41.4–54.1)	0.000

PD: Parkinson's disease; RBD: REM sleep behavior disorder; RBD−: RBD absent; RBD+: RBD present.

other hand, in the group of the PD patients with weekly hallucinations 45/101 (44.6%) had weekly nightmares and 56/101 (55.4%) did not have weekly nightmares.

At least weekly occurring bedwetting (21.0%) was more common in women (27.4%) than in men (15.6%) ($P < 0.001$). On the other hand, nocturia (the need to get up to urinate at least three times during the night; 15.9%) was more common in men (20.2%) than in women (10.7%; $P = 0.001$).

Patients with parasomnias, other than RBD, or isolated sleep symptoms, did not differ from the others in the quality of life measures neither in the depression scores.

Different models were used in the logistic regression analyses. We ended up with three different models. In the model 2 the adjusted logistic regression analysis showed that at least weekly occurring nightmares (OR 12.5; 95% CI 5.3 to 29.7), hallucinations (OR 5.1; 95% CI 2.1 to 12.4), sleep talking (OR 11.6; 95% CI 5.9 to 22.8), male gender (OR 1.9; 95% CI 1.1 to 3.1), and restless legs syndrome (OR 4.7; 95% CI 1.7 to 13.2) associated statistically significantly with the presence of RBD (Table 2). The model 3 was computed by limiting the number of items to seven factors. The reason for model 3 was to select only factors that can be obtained quickly during a clinical interview and examination. As shown in Table 2, the differences in the sensitivity or specificity of the different models are not clinically significant. There the model 3 can be used in clinical practice in the estimation of predicted probability of RBD. Examples of predicted probabilities, based on model 3, are shown in Table 3.

Using the results of the adjusted logistic regression analysis, we composed a new short questionnaire to detect possible RBD. The sum of questions gender (male = 1), nightmares and sleep talking gives a score from 0 to 11. This screening questionnaire (male/nightmare/ST), with the cut-off value is 5 points, has a sensitivity of 60.2% and a specificity of 94.3% (Table 2).

4. Discussion

Among non-motor manifestations of PD sleep problems, sleep related phenomena and sleepiness are found to be common. Using Non-Motor Symptom Questionnaire (NMS-quest), prevalence of clinically significant (roughly defined as having enough clinical impact to warrant treatment) insomnia is 38.8%, nocturia is 34.3%, EDS is 23.2%, RBD is 22.1%, RLS is 15.7%, intense dreaming is 10.3%, hyperhidrosis is 8.9% and hallucinations is 4.3%.[18] In the Priamo observational study, fatigue

Table 2
Logistic regression (without and with demographic control variables): other parasomnias and isolated sleep symptoms in association with RBD.

Other parasomnias / Isolated symptoms	Unadjusted OR (95% CI)	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95%)	Questions-score OR (95%)
Nightmares	15.8 (8.9 to 28.1)	12.3 (5.2 to 29.1)	12.5 (5.3 to 29.7)	13.9 (5.9 to 32.5)	
Night terrors	9.0 (3.0 to 26.8)	3.0 (0.4 to 23.5)	3.1 (0.3 to 26.2)	–	
Sleep walking	18.4 (2.4 to 143.3)	0.3 (0.02 to 3.7)	0.2 (0.01 to 3.4)	–	
Sleep Enuresis	3.1 (2.1 to 4.7)	1.8 (0.98 to 3.4)	1.8 (0.95 to 3.3)	2.0 (1.1 to 3.7)	
Hallucinations all	6.6 (4.0 to 10.8)	5.9 (2.5 to 13.8)	5.1 (2.1 to 12.4)	5.5 (2.4 to 12.5)	
Nocturnal sweating	1.4 (1.01 to 2.08)	1.2 (0.7 to 2.1)	–	–	
Bruxism	3.4 (1.6 to 7.5)	1.6 (0.5 to 5.3)	1.3 (0.4 to 4.7)	–	
Sleep talking	15.4 (9.3 to 25.3)	12.0 (6.2 to 23.5)	11.6 (5.9 to 22.8)	11.9 (6.1 to 23.1)	
Age		1.02 (0.99 to 1.05)	1.02 (0.99 to 1.05)	1.01 (0.98 to 1.04)	
Gender (1 = male)		2.0 (1.2 to 3.4)	1.9 (1.1 to 3.1)	2.0 (1.2 to 3.2)	
ESS > 10			1.5 (0.9 to 2.6)	–	
Fatigue			1.2 (0.7 to 2.1)	–	
OSAS			1.1 (0.5 to 2.2)	–	
RLS			4.7 (1.7 to 13.2)	4.5 (1.6 to 12.6)	
Screening test (≥5)[1]					24.9 (15.1 to 41.2)
Sensitivity of the model		65.4%	66.5%	67.6%	60.2%
Specificity of the model		91.1%	91.4%	90.2%	94.3%
Correct classification		81.8%	82.3%	81.9%	81.2%
Area under the curve		0.845	0.853	0.847	0.772

RBD REM sleep behavior disorder, OR odds ratio, and CI confidence interval. ESS Epworth Sleepiness Scale, OSAS obstructive sleep apnea syndrome, and RLS restless legs syndrome.

Table 3
Examples of predicted probabilities of RBD, computed from the Model 3, in patients (aged around 68 years) with Parkinson's disease.

Gender	Age	Sleep talking weekly	Nightmares weekly	Hallucinations weekly	Presence of RLS	Enuresis weekly	Probability of RBD
Male	60	No	No	No	No	No	8.3%
Male	60	Yes	No	No	No	No	44.1%
Male	60	Yes	Yes	No	No	No	87.8%
Male	60	Yes	Yes	Yes	No	No	95.3%
Male	60	No	No	Yes	No	No	20.3%
Male	60	No	No	Yes	Yes	No	41.3%
Male	60	No	No	Yes	Yes	Yes	63.1%
Woman	60	Yes	No	No	No	No	27.0%
Woman	60	No	Yes	No	No	No	27.8%
Woman	60	Yes	Yes	No	No	No	77.0%
Woman	60	Yes	Yes	Yes	No	No	90.4%
Woman	60	No	No	Yes	Yes	Yes	44.5%
Man	75	Yes	No	No	No	No	46.4%
Man	75	Yes	Yes	Yes	No	No	95.7%
Man	75	No	No	Yes	Yes	Yes	65.3%
Man	75	Yes	Yes	Yes	Yes	Yes	99.3%

was the most common symptom (58%).[19] The prevalences of these symptoms are consistent with our results. However, except for RBD, nightmares and hallucinations, we have not found previous systematic studies about the occurrence of other parasomnias in patients with PD.

The main findings of the present study were the prevalent combination of other parasomnias and isolated sleep related symptoms with RBD symptoms in PD patients. Isolated RBD (RBD without any other parasomnia) was rare. Originally, parasomnia overlap disorder (POD) refers to a sleep disorder characterized by the association of RBD with NREM-sleep parasomnia (SW) in the same patient [20]. The previous reports on parasomnias, other than RBD, among PD patients have been small. Of 165 consecutive patients with PD seen for 2 years, 6 patients with adult-onset SW were identified [11]. Night walking was also reported in 10 of 93 patients with RBD of different origin, including PD. Five of these 10 patients had underlying neurodegenerative diseases, and two patients with SW had confusional arousals during the video-PSG indicating the parasomnia overlap syndrome. The authors discuss the possibility, that all 10 patients with SW represent this overlap disorder [10].

Parasomnias may be explained on the basis that wakefulness and sleep are not mutually exclusive states, and abnormal intrusion of wakefulness into non-REM (NREM) sleep produces arousal disorders, and intrusion of wakefulness into REM sleep produces recurrent isolated sleep paralysis, nightmare disorder and RBD [21]. These undesirable emotional or physical events that accompany sleep are inappropriate for the time of occurrence but may seem purposeful or goal directed. They occur more commonly in children and decrease in frequency in the adult population. However, their occurrences may increase in neurologically affected adults.

According to Bjorvatn et al. the prevalence of at least weekly occurring parasomnias in adults is: sleep walking 0.6% (95% CI 0.2–1.1), sleep talking 6.3% (4.7–7.7), sleep terror 1.0% (0.4–1.6), and nightmares 2.8% (1.8–3.9) [22]. In patients with PD (present study) the respective prevalences were: SW 1.9% (0.8–3.0), ST 21.7% (18.5–24.9), night terrors 3.9% (2.4–5.5) and nightmares 17.2% (14.3–20.2). Our finding is that 3.8% of patients with PD without RBD see frequently nightmares, which is similar to the prevalence of nightmares in general population. The prevalence of nightmares is much more common (38.3%) in PD patients with RBD. The logistic regression analysis showed both nightmares and hallucinations to have independent and significant associations with RBD. However, 60.5% of nightmare PD patients did not have hallucinations and no association with RBD. They were more often women. The sex difference in the prevalence of nightmares may be contributed by the higher rate of dream recall in women.

Previous studies have shown, that the prevalence and severity of hallucinations significantly increase with the duration of PD, and that the nightmares have no predictive influence on the future development of hallucinations [23]. Using the UPDRS I sub score, item 2 (thought disorder) the frequent hallucinations have been estimated to occur in 18% of Parkinson's patients with Parkinson's disease [24]. In our series, we found this frequency to be smaller 15.3%. On the other hand, previous epidemiological studies have not made the distinction according to the presence of RBD. RBD has been found to associate with cognitive impairment and predict development of dementia in PD [25]. The association of cognitive status and other parasomnias was not possible to evaluate in this questionnaire study.

Enuresis in children is defined in DSM-IV as repeated voiding of urine in the bed at least twice per week for at least three consecutive months. Nocturnal incontinence occurs in 1% of young adults, with rates being higher in males. Infrequent bedwetting (only once or less a week) in children is six times more commoner than enuresis [26]. In our series, weekly occurring bedwetting was more common among females, and nocturia occurred more often with males. Enuresis nocturna may be classified as a parasomnia but bedwetting/nocturia/incontinence may also be a manifestation of autonomic dysfunction. Their differentiation from each other is very difficult in a questionnaire study.

Occurrence of bruxism in patients with PD has not been reported. The two most-representative large-scale epidemiological studies conducted by telephone survey coincide in estimating an approximate SB prevalence of 8% in the general population. The prevalence of SB in persons over age 65 is 3% [2]. As the prevalence of tooth grinding decreases linearly with age, SB is not associated with PD but perhaps more likely with RLS [27,28]. The prevalence rate of idiopathic night sweats in adult population has not been reported.

The strength of our study is a rather large sample size of patients with PD. Altogether 1500 subjects from the Finnish Parkinson Association (FPA) were randomly selected. About 50% of Parkinson patients are actually members of FPA. They become members of the association after some years after their diagnosis has been confirmed, but some leave the association in the advanced state. Our sample is a representative sample of “middle stage” Finnish patients with PD.

Our study has its limitations. Only a questionnaire was used and it is possible that the sample includes besides idiopathic Parkinson's disease also some other patients using PD medication e.g. patients with Lewy Body Dementia or other types of Parkinsonism. As subjects with significant cognitive dysfunction may be missing, our results cannot be generalized to PD patients with serious memory complaints. As concerns RBD our data is also based on the questionnaire and we do not have polysomnographic confirmation of the disorder. Because of the large number of participants and the fact that the participants were from different parts of Finland, we did not have sufficient funding to include polysomnography.

There might also be some under-reporting as parasomnias may not be detected among persons, who sleep alone. Also some symptoms, such as sleep talking, are often under-reported. Patients with Parkinson's disease have many non-motor symptoms that can act as mimics of parasomnias and isolated sleep symptoms. A thorough interview with each subject made by an experienced sleep researcher should be done to differentiate mimics from true findings. Finally, our questionnaire included questions on the usage of medications but not on the dosages. Therefore, we the exact role of medications is missing.

5. Conclusions

In Parkinson's disease, there seems to be a significant overlap of RBD and other parasomnias and isolated sleep symptoms. Thus, if a patient with PD complains of at least weekly occurring parasomnias (nightmares and sleep talking, or sleepwalking), a clinician should suspect a possibility of RBD and consider further sleep studies in order to confirm the diagnosis. This is a cross-sectional questionnaire study that can at best propose new associations, and prospective studies are needed to study whether some parasomnias may predict RBD or PD.

Documentation of author roles

Ari Ylikoski, Execution of the research project, design and execution of statistical analysis, writing of the first draft, and editing the drafts.

Kirsti K. Martikainen, Conception and organization of the research project, design, review and editing of the drafts.

Markku Partinen, Conception, organization and execution of research project, design and execution of statistical analysis, and editing of the drafts.

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Conflict of interest

There is no conflict of interest.

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